FPEL03150001(Amended under Article 34 of the PCT)

Light Emitting Diode Lamp and Manufacturing Method thereof

Technical field

This invention relates to a light-emitting diode lamp and the manufacturing method thereof.

Background art

Light-emitting diode has the advantages of long life-span, small volume and light weight, so as a new type of light source, it has been applied more and more widely in the fields like display and illuminating. In practical application, it is required in most occasions that the light-emitting diode lamp should have greater brightness and smaller luminous angle (i.e., parallel light in an ideal case). Since the light-emitting diode chip is a area light-emitting source, the luminance intensity thereof is close to the cosine distribution, and the luminous angle is relatively large, it is used only after encapsulating in various manners in practical application.

The sectional view of the light-emitting diode lamp that is encapsulated by the prior art encapsulating manner is as shown in Fig. 1, wherein 101 is the anode pin of the light-emitting diode lamp, 102 is the cathode pin of the light-emitting diode lamp, and a concave reflector is provided thereon, 103 is the light-emitting diode chip which is within the concave reflector, 104 is the epoxy resin encapsulation, on the top of which a spherical condenser lens 104 is formed, whose radius of curvature is r, and the distance from the focal point of the lens to the top of the spherical surface is f. In order to make light emit by a relatively small angle, the

light-emitting diode chip 103 is on the focal point of the spherical lens. According to the focal length equation f=r*n2/(n2-n1), wherein n2 is the refractive index of the epoxy resin which is about 1.5, and n1 is the refractive index of the air which is about 1, then f is three times of r. Thus light that is smaller than the angle of 30° emitted from the light-emitting diode chip emits at an illuminating angle approximate to 0° through the condenser lens at the position of the focal point of the condenser lens. When illuminating angle of less than 3° is required, the utilization ratio of the light is less than 30%.

The laid-open description of Chinese patent application for invention numbered CN1156908A has disclosed a light emitting diode, which enables the light emitted by the light emitting diode to be used almost 100% by means of total reflection, but light emitted therefrom is non-parallel light. The U. S Patent US5001609 has the similar defect.

The Japanese patent JP 60063970 has disclosed a parallel light radiator having light-emitting diode chips. Owing to the influence of the supporting base of the light-emitting diode (see Fig. 3 thereof), the light-emitting surface of the light-emitting diode chip does not right face to the reflector, thus most of the light cannot be reflected by the reflection plate, thereby the light utilization ratio of the emitted parallel light is low.

European patent application EP 0570987A1 recited a bicycle rear light. Although the LED semiconductor chip therein is located on the focal point of the reflector (see Fig. 5 thereof), the light-emitting surface of said LED faces outside, thus most of the light cannot be reflected by the reflection surface, thereby the light utilization ratio of the emitted parallel light is low. Meanwhile, when there are a plurality of light-emitting diodes, it is impossible that all of these light-emitting diodes are positioned on the focal point of the curved reflection surface, thus the

light utilization ratio of the parallel light is also reduced.

Contents of the invention

Therefore, in order to overcome the defects of low utilization ratio and low luminance intensity of light of the prior art light-emitting diode lamp when small illuminating angle is required, the present invention provides a new encapsulated light-emitting diode lamp, which enables the encapsulated light-emitting diode lamp to be used as parallel light source or small angle light source, and to have high luminance intensity which could be widely applied to the fields like car lamps, projector light source, illumination light source, etc.

The principle of the present invention is that light emitted from the focal point of the curved reflection surface is emitted in the direction parallel to the axis of the curved surface after being reflected by said curved reflection surface. The light-emitting diode chip is put on the focal point of the corresponding curved reflective mirror, and the light-emitting surface of the light-emitting diode chip is made to face to the reflective mirror and form an angle of ±0-85°with respect to the axis of the reflector, then except that a small part of the light emitted from the chip directly escapes from the opening of the reflective mirror, the rest of the light is parallel to the axis of said curved surface after being reflected by the reflective mirror, thereby the illuminating angle thereof is approximate to 0° and thus the utilization ratio of light is high. Since the light-emitting diode chip is not point light source but area light source, in order to increase the utilization ratio of the reflector, a plurality of light-emitting diodes may be disposed in the shape of regular polygon with the light-emitting surface facing outside. The illuminating angle of the lampwick formed in this manner is 360°, so the luminance intensity is increased without increasing the volume of the lamp. The volume of

the lampwick formed by disposing a plurality of light-emitting diodes in the shape of regular polygon is large, and thus cannot be considered as point light source any more, therefore, said curved reflector is divided into a plurality of curved surfaces, so that each light-emitting diode chip corresponds to a focal point of a curved surface. When the reflector is large, the above single chip of light-emitting diode could be consisting of a plurality of chips, while said curved reflector could still be considered as a point light source.

Preferably, said curved surface is a paraboloid.

In a preferred embodiment, said light-emitting surface faces to the reflective mirror and forms the angle of ±0-30° with respect to the axis of the reflector.

The present invention further provides a method of manufacturing said light-emitting diode lamp, wherein the reflector having a curved reflection surface is manufactured first; then the lampwick having one or a plurality of light-emitting diode chip(s) or chip group(s) is manufactured, in which the light-emitting surface of the light-emitting diode chip(s) or chip group(s) forms the angle of ±0-85° with respect to the axis of said reflector; finally, said lampwick is placed in said reflector and is adjusted to make said light-emitting diode chip(s) or chip group(s) be in the focal point of said curved reflection surface.

Description of figures

The embodiments of this invention are described in connection with the figures in the following, wherein:

What is claimed is:

1. A light-emitting diode lamp consisting of a lampwick (203, 204, 205) including light-emitting diode chip(s) (203) and a reflector (202), the light-emitting surface (206) of the light-emitting diode chips (203) on said lampwick faces to the curved reflection surface (207) of said reflector (202), and is positioned on the focal point of said curved reflection surface, characterized in that said light-emitting surface (206) faces to the curved reflection surface (207) of said reflector (202), and forms an angle (α) of $\pm$0-85° with respect to the axis (I) of said reflector (202).

2. The light-emitting diode lamp according to claim 1, characterized in that said reflector (202) is formed of a plurality of reflective mirrors, so that the light-emitting surfaces (206) of a plurality of light-emitting diode chips (203) or chip groups are positioned on the focal point of each reflective mirror, respectively.

3. The light-emitting diode lamp according to claim 2, characterized in that the axes of said reflective mirrors are parallel to the axis (I) of the reflector (202) and are distributed evenly at equal distance centered at the axis (I) of the reflector.

4. The light-emitting diode lamp according to claim 2 or 3, characterized in that the number of said light-emitting diode chips or chip groups and said reflective mirrors is four.

5. The light-emitting diode lamp according to any one of the preceding claims, characterized in that said curved reflection surface (207) is a paraboloid.

6. The light-emitting diode lamp according to any one of the preceding claims, characterized in that said light-emitting surface (206) forms an angle (α) of ±0-30° with respect to the axis (I) of the reflector.

7. The light-emitting diode lamp according to any one of the preceding claims, characterized in that said lampwick (203, 204, 205) is formed of a lampwick base (204, 205) of the shape of regular prism and one or more light-emitting diode chips or chip groups, and each light-emitting diode chip or chip group is located at one side of said lampwick base, and the lampwick base is formed of a first conductive layer (205) and a second conductive layer (204) which are insulated to each other.

8. The light-emitting diode lamp according to any one of the preceding claims, characterized in that it is encapsulated with resin to be dustproof and dampproof.

9. A method of manufacturing the light-emitting diode lamp as stated in claim 1 or 2, comprising the steps of:
(1) manufacturing the reflector (202) having a curved reflection surface (207);
(2) manufacturing the lampwick (203, 204, 205) having the light-emitting diode chip(s) (203) or chip group(s), and making the light-emitting surface (206) of said light-emitting diode chip(s) (203) or chip group(s) to form an angle (α) of ±0-85° with respect to the axis (I) of said reflector (202);
(3) putting said lampwick into said reflector (202) and adjusting said lampwick to make said light-emitting diode chip(s) or chip group(s) be at the focal point of said curved reflection surface.

10. The method according to claim 9, characterized by comprising a further step of encapsulating said lamp with resin.

11. The method according to claim 9 or 10, characterized in that said curved reflection surface (207) is a paraboloid.

12. The method according to any one of claims 9-11, characterized in that the angle (α) between said light-emitting surface (206) and the axis (I) of said reflector is ±0-30°.

13. The method according to any one of claims 9-12, characterized in that said reflector (202) is formed of a plurality of reflective mirrors, the axes of said reflective mirrors are parallel to the axis (I) of said reflector (202), and are distributed evenly at equal distance centered at the axis (I) of the reflector, such that the light-emitting surfaces (206) of a plurality of light-emitting diode chips (203) or chip groups are positioned on the focal point of each reflective mirror, respectively.

14. The method according to claim 13, characterized in that the number of said light-emitting diode chip(s) or chip group(s) and said reflective mirrors is four.